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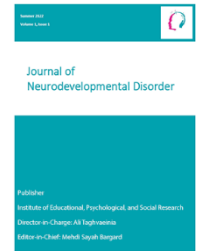
Prediction of Mathematics Anxiety and Mathematics Performance by Teacher Characteristics in Secondary School Students

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ABSTRACT

Objective: This study aimed to examine the relationship between teacher characteristics and both mathematics anxiety and mathematics performance among secondary school students.

Methods and Materials: Employing a descriptive-correlational research design, the study focused on a statistical population of high school students in Mysore, India. A sample of 400 students was selected using a multi-stage cluster sampling method. Participants completed the Mathematics Anxiety Scale (MAS), a mathematics achievement test (comprising problem-solving and calculation questions), and a teacher demographic questionnaire (including teacher age, education, and years of experience). Data were analyzed using multiple regression techniques.

Findings: The findings indicated that teacher characteristics (age, education, and years of experience) were significantly negatively correlated with mathematics anxiety, while demonstrating a significant positive correlation with mathematics performance. Additionally, multivariate regression analysis revealed that the combination of these teacher characteristics serves as a strong predictor of both mathematics anxiety and mathematics performance.

Conclusion: In light of these results and the importance of teachers' educational qualifications in influencing mathematics anxiety and performance, it is recommended that teacher preparation and employment practices prioritize candidates with higher educational degrees. Furthermore, all teachers should receive comprehensive training in general, specialized, and pedagogical subjects through universities or other teacher preparation institutions.

Keywords: Teacher Characteristics, Mathematics Anxiety, Mathematics Performance.

1.   Introduction

The psychological factors influencing academic contexts and their effects are increasingly significant concerns for educational researchers and practitioners. A prevalent issue is mathematics anxiety, which many students encounter in schools today (Khorshidi et al., 2024; Seadatee Shamir, 2024). Reported consequences of mathematics anxiety include avoidance of the subject and decreased mathematics achievement (Bornaa et al., 2023). This phenomenon was first identified in 1954 by Gough as "math phobia" (Clarke, 2021). More than 30% of secondary school students in countries belonging to the Organization for Economic Co-operation and Development (OECD) report experiencing stress and anxiety when tackling mathematics problems and schoolwork (Bedetti & Elisei, 2019). Despite the central role of mathematics in education, global mathematics performance remains suboptimal (Fokuo et al., 2022). Uludag (2022) argued that mathematics anxiety significantly impacts students' academic success, with those experiencing high levels of anxiety being less likely to succeed in careers related to science, technology, engineering, and mathematics (STEM) (Uludag, 2022).

In a recent meta-analysis, Barroso et al. (2021) identified a small to moderate negative correlation between mathematics anxiety and mathematics achievement. However, some studies have suggested that mathematics anxiety does not necessarily predict achievement (Abín et al., 2020). For example, Wang et al. (2018) found that high levels of exam-related mathematics anxiety were present across all levels of mathematics motivation (high, medium, and low). They also noted that higher learning-related mathematics anxiety was generally linked to lower mathematics motivation. Thus, according to Wang et al. (2018), students with high mathematics anxiety are not necessarily unmotivated in mathematics (Wang et al., 2018).

Richardson and Suinn (1972) defined mathematics anxiety in terms of its debilitating effects on performance, noting that feelings of tension and anxiety interfere with the manipulation and resolution of mathematical problems in both everyday life and academic settings (Richardson & Suinn, 1972). Similarly, Suinn (1988) and Moustafa, Porter, and Megreya (2020) described mathematics anxiety as involving tension and anxiety that hinder numerical manipulation and problem-solving across diverse contexts (Moustafa et al., 2020; Suinn et al., 1988). Students who experience mathematics anxiety often lack confidence in their mathematical abilities, tend to take the minimum required mathematics courses, and thus limit their career opportunities (Daker et al., 2021; Wong et al., 2024).

The interpersonal relationship between teachers and students is crucial in addressing mathematics anxiety. While some teachers prefer a self-controlled and conventional learning environment, others aim to foster a positive classroom atmosphere where students feel safe to take risks and engage creatively (Alfayo, 2021).

School and classroom variables play an essential role in shaping students' personalities and academic outcomes (Wong et al., 2024). Among these variables, teachers' socio-educational backgrounds are particularly significant, as they influence the classroom environment and student achievement. McFarland (2001) emphasized the role of teacher qualifications and socio-educational factors in student outcomes (McFarland, 2001). Similarly, Bello (2017) argued that teachers' qualifications and experience significantly enhance the quality of education provided (Bello, 2017). Research on school-level variables indicates that teacher quality is the most critical factor in predicting student outcomes (Uludag, 2022; Wang et al., 2018; Wong et al., 2024). The impact of having a highly skilled teacher is profound and enduring.

Although researchers generally agree on the importance of teacher quality in influencing student outcomes, the relationship between specific teacher credentials (e.g., experience and degree level) and socio-educational background remains unclear (Alfayo, 2021). Furthermore, there is a need for studies that explore the influence of teacher variables on mathematics performance and other psychological factors.

The present study aims to examine the effects of teacher variables (age, education, and years of experience) on mathematics anxiety and mathematics performance. It hypothesizes that the combination of these variables can serve as a reliable predictor of both outcomes. Accordingly, the following hypotheses are proposed:

- There is a significant correlation between teacher variables and mathematics anxiety.
- There is a significant correlation between teacher variables and mathematics performance.
- Teacher variables can serve as reliable predictors of mathematics anxiety and mathematics performance.

2.   Methods and Materials

2.1.   Study Design and Participants

This study employed a descriptive-correlational research design to examine the relationship between teachers' socio-educational backgrounds and their influence on mathematics anxiety and mathematics performance among secondary school students. The study was conducted in Mysore, India, and involved a sample of 400 ninth-grade students, comprising 186 males and 214 females. Participants were randomly selected from 16 high schools across the region using a multi-stage cluster sampling technique to ensure a representative sample. The study focused on the interactions between teacher variables—age, experience, and education—and their impact on student outcomes in mathematics.

2.2.   Measures

2.2.1.   Mathematics Anxiety Rating Scale-India (MARS-I)

This questionnaire, developed by Karimi (2008), consists of 31 items that assess situations inducing mathematics anxiety. It includes two subscales: Math Test Anxiety (15 items) and Numerical Tasks (16 items). Each item is rated on a five-point Likert scale, ranging from "Very Much Anxious" (5) to "Not At All Anxious" (1). The psychometric properties of this scale have been rigorously evaluated. The correlation between MARS-I scores and those of the original Mathematics Anxiety Rating Scale (MARS, 1972) was 0.87. The test-retest reliability over a two-week interval was 0.85, and the internal consistency, as measured by Cronbach's alpha, was 0.88 (Karimi, 2008).

2.2.2.   Researcher-Developed Mathematics Test

A researcher-developed test was used to measure mathematics achievement in high school students. This test was designed based on the objectives and content outlined in the mathematics curriculum for the respective grade level.

2.3.   Data Analysis

The collected data were analyzed using descriptive and inferential statistical methods. Descriptive statistics, including means and standard deviations, were calculated to provide a general overview of mathematics anxiety and performance levels among the participants based on teacher variables. Correlation analysis was conducted to determine the strength and direction of relationships between teacher variables and the dependent variables of mathematics anxiety and performance. Multiple regression analyses were then performed to evaluate the predictive power of teacher variables on these outcomes. The analysis followed a stepwise approach, allowing for the identification of individual and combined effects of teacher age, experience, and education. The statistical significance of relationships and predictions was assessed at $p < 0.05$ and $p < 0.01$ levels, ensuring robust conclusions. The results were interpreted within the context of existing literature to provide a comprehensive understanding of the dynamics between teacher characteristics and student outcomes.

3.   Findings and Results

Descriptive statistics for the variables are presented in Table 1.

Table 1

Descriptive statistics for research variables

Variable	category	N	Mathematics Anxiety		Mathematics Performance	
			Mean	S.D	Mean	S.D
Teacher's experience	0-10 years	142	66.719	10.22	66.22	6.219
	10-20 years	153	62.28	8.31	68.41	5.94
	more than 20 years	105	64.00	7.98	71.34	6.56
	total	400	64.66	9.20	68.53	6.64
Teacher's education	Bachelor and lower	189	65.48	11.01	66.59	7.03
	upper bachelor	211	63.90	7.05	63.89	5.70
	Total	400	64.66	9.20	68.52	6.63
Teacher's age	Less than 30 years	154	65.37	9.57	66.50	6.99
	31- 45 years	195	64.05	7.07	70.27	5.85
	More than 45 years	51	64.61	15.87	68.53	6.36
	Total	400	64.66	9.20	68.53	6.64

The coefficients of correlation between teacher variables, mathematics anxiety, and mathematics performance are displayed in Table 2.

Table 2

Coefficients of Correlation Between Teacher Variables, Mathematics Anxiety, and Mathematics Performance

Teacher Variables	Mathematics Anxiety	Mathematics Performance
Teacher Age	-0.15	0.23 (*)
Teacher Experience	-0.53 (**)	0.57 (**)
Teacher Education	-0.39 (*)	0.51 (**)

*p < 0.05, **p < 0.01 (1-tailed). N = 400.

The coefficients of correlation in Table 2 indicate an inverse relationship between two aspects of teacher variables and mathematics anxiety. Specifically, teacher experience was significantly negatively correlated with mathematics anxiety (r = -0.53, p < 0.01), and teacher education was similarly negatively correlated with mathematics anxiety (r = -0.39, p < 0.05). However, no significant relationship was found between teacher age and mathematics anxiety.

In contrast, significant positive relationships were observed between all three teacher variables and mathematics performance. Teacher age was positively correlated with mathematics performance (r = 0.23, p < 0.05), while teacher experience (r = 0.57, p < 0.01) and teacher education (r = 0.51, p < 0.01) also showed significant positive correlations.

To assess the predictive power of teacher variables on mathematics anxiety and mathematics performance, multiple regression analysis was conducted. The results are presented in Table 3.

Table 3

Coefficients of Multiple Regression Analysis

DV	IV	B	Beta	t	Adjusted R-Square	F
Mathematics Anxiety	Teacher Experience	-1.452	-0.536	-3.357***	0.321	5.270**
	Teacher Education	-1.825	-0.399	-1.873		
	Teacher Age	0.228	-0.159	0.294		
Mathematics Performance	Teacher Experience	2.598	0.577	9.148***	0.389	47.681***
	Teacher Education	3.719	0.510	5.815***		
	Teacher Age	0.147	0.230	0.288		

DV = Dependent Variable, IV = Independent Variable. *p < 0.05, **p < 0.01, ***p < 0.001.

Descriptive statistics indicate that teacher variables significantly influence mathematics anxiety and mathematics performance.

For mathematics anxiety, multiple regression analysis revealed that the combination of teacher variables provided a statistically significant negative prediction (F(3, 396) = 5.27, p < 0.001; Adjusted R-Square = 0.321). Teacher experience was the only significant predictor (B = -1.452, t = -3.357, p < 0.001), while teacher education and teacher age were not significant predictors.

For mathematics performance, multiple regression analysis showed that teacher variables collectively provided a statistically significant positive prediction (F(3, 396) = 47.68, p < 0.001; Adjusted R-Square = 0.389). Teacher experience (B = 2.598, t = 9.148, p < 0.001) and teacher

education (B = 3.719, t = 5.815, p < 0.001) were significant predictors, while teacher age was not.

4.   Discussion and Conclusion

The present study aimed to evaluate the relationship between teachers' socio-educational backgrounds and both mathematics anxiety and mathematics performance. Based on the results, the following conclusions can be drawn:

a. There is a significant negative correlation between teachers' socio-educational backgrounds and mathematics anxiety.

b. There is a significant positive correlation between teachers' socio-educational backgrounds and mathematics performance.

Additionally, the findings indicate that mathematics anxiety and mathematics performance in students can be predicted by a combination of teacher variables, including age, experience, and education level.

This study utilized a sample of students from three states in southern India to explore the relationship between teacher variables and mathematics anxiety and performance. The results clearly demonstrated an inverse relationship between teacher variables (age, experience, and education) and mathematics anxiety. Furthermore, a positive relationship was observed between teacher variables and mathematics performance.

The results of the multiple regression analyses for the two models revealed that a combination of teachers' age, experience, and education levels serves as a strong predictor of both mathematics anxiety and mathematics performance. Specifically, students' mathematics anxiety was found to be influenced by these teacher characteristics. Other researchers have reported similar findings, indicating that higher levels of these teacher characteristics are associated with a reduction in mathematics anxiety (Cahyawati et al., 2023; Wong et al., 2024). Mathematics anxiety, a specific form of state anxiety that occurs in academic settings, can be mitigated by employing more experienced teachers and those with higher levels of education.

The second part of this study demonstrated a significant relationship between teacher variables and mathematics performance. Previous studies (Limega & Cia Cai, 2023; Moustafa et al., 2020) also support these findings.

In light of these results and the importance of teachers' educational qualifications in influencing mathematics anxiety and performance, it is recommended that teacher preparation and employment practices prioritize candidates with higher educational degrees. Furthermore, all teachers should receive comprehensive training in general, specialized, and pedagogical subjects through universities or other teacher preparation institutions. According to McLeod (1993), the ages between 9 and 14 are critical for the development of mathematics anxiety (McLeod, 1993). It is therefore advisable to assign more experienced teachers to these grade levels to better address this issue.

Authors' Contributions

Authors contributed equally to this article.

Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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